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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVII BROOKLYN, N. Y., APRIL 3, 1929 No. 1—3

A SELECTED LIST OF PUBLICATIONS ON GARDENING AND WILD FLOWERS

The following list of titles is not intended to be an exhaustive bibliography, but only to include the more popular, readily accessible, and, with a few exceptions, moderately priced publications.

The asterisk indicates publications in the Brooklyn Botanic Garden Library, which is open free to the public daily.

GARDENING

CYCLOPEDIAS AND MANUALS

* Bailey, L. H. The standard cyclopedia of horticulture. N. Y. Macmillan Co., 1928. 3 vols. illus. $25.00.

* ———. Manual of gardening. N. Y. Macmillan Co., 1923. 541p. illus. $3.00. (The rural manuals.)

* ———. The nursery manual; a complete guide to the multiplication of plants. N. Y. Macmillan Co., 1920. 452p. illus. $2.50. (The rural manuals.)

* ———. The pruning manual. N. Y. Macmillan Co., 1925. 407p. illus. $2.50. (The rural manuals.)

* Britton, N. L. Manual of the flora of the Northern States and Canada. N. Y. Holt & Co., 1907. 1122p. illus. $2.50.

* Britton, N. L., and Brown, Addison. Illustrated flora of the Northern States and Canada. 2d edition revised and enlarged. N. Y. Scribner's Sons, 1913. 3 vols. illus. $13.50.

Hottes, A. C. 1001 garden questions answered. N. Y. De LaMare Co., Inc., 1927. 320p. illus. $2.00.

* American Joint Committee on Horticultural Nomenclature. Standardized plant names. Harrisburg, Pa. Mount Pleasant Press, 1924 548p. $6.00.

SOILS

* Bear, F. E. Soil management. N. Y. Wiley & Sons, Inc., 1927. 412p. illus. $3.50.

* Burkett, C. W. Soils, their properties, improvement, management and the problems of crop growing and crop feeding. N. Y. Judd Publ. Co., 1917. 303p. illus. $1.75.

* King, F. H. Soil management. N. Y. Judd Publ. Co., 1916. 303p. illus. $2.00.

* Russell, E. J. Soil condition and plant growth. N. Y. Longmans, Green & Co., 1927. 516p. illus. $6.50.

INSECT PESTS AND FUNGOUS DISEASES

* Duggar, B. M. Fungous diseases of plants. N. Y. Ginn & Co., 1909. 508p. illus. $3.20.

* Felt, E. P. Manual of tree and shrub insects. N. Y. Macmillan Co., 1924. 382p. illus. $3.50. (The rural manuals.)

* Heald, F. D. Manual of plant diseases. N. Y. McGraw-Hill Book Co., 1926. 891p. illus. $7.00.

* Mason, H. F. Spraying, dusting and fumigating of plants. N. Y. Macmillan Co., 1928. 539p. illus. $5.00. (The rural manuals.)

* Sanderson, E. D. Insect pests of farm, garden and orchard. 2d edition, revised and enlarged. N. Y. Wiley & Sons, 1921. 684p. illus. $4.50.

* Stevens, F. L. Plant disease fungi. Revised edition. N. Y. Macmillan Co., 1925. 469p. illus. $5.00.

VEGETABLE GARDENING

* Bailey, L. H. Principles of vegetable gardening. N. Y. Macmillan Co., 1921. 489p. illus. $4.00.

* French, Allen. How to grow vegetables and garden herbs. N. Y. Macmillan Co., 1917. 312p. illus. $2.00.

* Kains, M. G. Culinary herbs. N. Y. Judd Publ. Co., 1920. 143p. illus. $1.00.

* Lloyd, J. W. Productive vegetable growing. Phila. Lippincott Co., 1925. 343p. illus. $3.00.

* Rockwell, F. F. Around the year in the garden. N. Y. Macmillan Co., 1926. 350p. illus. $2.50.

Watts, R. L. Vegetable forcing. N. Y. Judd Publ. Co., 1924. 431p. illus. $2.50.

LAWNS

* Barron, Leonard. Lawn making. N. Y. Doubleday, Page & Co., 1923. 176p. illus. $2.00.

LANDSCAPE GARDENING

* Bottomley, M. E. The design of small properties, a book for the house owner in city and country. N. Y. Macmillan Co., 1928. 233p. illus. $3.00.

Cridland, R. B. Practical landscape gardening. N. Y. De LaMare Co., Inc. 1927. 280p. illus., planting plans, sketches. $2.50.

* Crisp, Frank. Mediaeval gardens. Lond. John Lane, 1924. 2 vols. plates. $35.00.

Forestier, J. C. N. Gardens. A note-book of plans and sketches. Translated from the French by Helen Morgenthau Fox. New edition. N. Y. Scribner's Sons, 1928. 247p. illus. $5.00.

Gothein, M. L. History of garden art. Translated from the German by Mrs. Archer-Hind. Edited by Walter P. Wright. 2 vols. illus. N. Y. Dutton & Co., 1928. $25.00.

Hamblin, S. F. Lists of plant types for landscape planting. Harvard Univ. Press, 1923. $5.00.

* Humphreys, P. W. Practical book of garden architecture. Phila. Lippincott Co., 1914. 330p. illus. $7.50.

* Mawson, T. H. The art and craft of garden making. N. Y. Scribner's Sons, 1926. 5th edition. 440p. illus. $25.00.

Nichols, R. S. Italian pleasure gardens. N. Y. Dodd, 1928. 309p. illus. $10.00.

Powell, E. P. Hedges, windbreaks, shelters and live fences. N. Y. Judd Publ. Co., 1922. 140p. illus. $1.00.

Rehmann, Elsa. Garden-making. N. Y. Houghton, 1926. 208p. illus. $3.50.

* Roberts, E. A., and Rehmann, Elsa. American plants for American gardens. N. Y. Macmillan Co., 1929. 131p. illus. $2.00.

* Rogers, W. S. Planning your garden. N. Y. Doubleday, Page & Co., 1927. 301p. illus. $2.00.

* Tabor, Grace. The landscape gardening book, wherein are set down the simple laws of beauty and utility which should guide the development of all grounds. N. Y. McBride, Winston & Co., 1911. 180p. illus. plans. $1.50.

———. Old-fashioned gardening. N. Y. McBride, 1925. 263p. illus. $3.00.

Van Rensselaer, M. G. (Mrs. Schuyler). Art out-of-doors. New and enlarged edition. N. Y. Scribner's Sons, 1925. 482p. illus. $2.50.

Waugh, F. A. Book of landscape gardening. N. Y. Judd Publ. Co., 1926. 236p. illus. $2.00.

ORNAMENTAL TREES AND SHRUBS

* Bailey, L. H. Cultivated evergreens. N. Y. Macmillan Co., 1928. 434p. illus. $3.00.

* Blakeslee, A. F., and Jarvis, C. D. Trees in winter. N. Y. Macmillan Co., 1926. 446p. illus. $2.50.

* Cloud, K. M.-P. The cultivation of shrubs. N. Y. Dodd, 1927. 305p. illus. $2.50.

* Greeves-Carpenter, C. F. Care of ornamental trees. N. Y. Macmillan Co., 1928. 70p. illus. $1.25.

* Hottes, A. C. The book of shrubs. N. Y. De LaMare Co., Inc., 1928. 371p. illus. $3.00.

* Hough, R. B. Handbook of the trees of the northern states and Canada east of the Rocky Mountains. R. B. Hough Co., Lowville, N. Y., 1907. 470p. illus. $8.00.

* Nuttall, G. E. Beautiful flowering shrubs. Illus. from autochromes by H. E. Corke. London. The Waverley Book Co., Ltd. No date. 279p. 21s.

* Rehder, Alfred. Manual of cultivated trees and shrubs. N. Y. Macmillan Co., 1927. 930p. $10.50.

* Rockwell, F. F. Evergreens for the small place. N. Y. Macmillan Co., 1928. 84p. illus. $1.00. (Home garden handbooks.)

* ———. Shrubs. N. Y. Macmillan Co., 1927. 76p. illus. $1.00. (Home garden handbooks.)

* Sargent, C. S. Manual of the trees of North America. Boston. Houghton, Mifflin & Co., 1926. 910p. illus. $12.50.

* Schrepfer, F. A. Hardy evergreens. N. Y. Judd Publ. Co., 1928. 127p. illus. $1.25.

* Trelease, William. Plant materials of decorative gardening. The woody plants. Urbana, publ. by the author, 1926. 188p. $1.25.

* ———. Winter botany; a companion volume to the author's Plant materials of decorative gardening. Urbana, publ. by the author, 1925. 396p. illus. $2.50.

* Waugh, F. A. Hardy shrubs. N. Y. Judd Publ. Co., 1928. 124p. illus. $1.25.

* Wilson, E. H. Aristocrats of the garden. N. Y. Doubleday, Page & Co., 1926. 312p. illus. $5.00.

FLOWER GARDENING

* Bailey, L. H. The garden lover. N. Y. Macmillan Co., 1928. 154p. $1.50.

Cloud, D. M.-P. Culture of perennials. N. Y. Dodd, 1926. 271p. illus. $2.50.

* Cummins, J. H. My garden comes of age. N. Y. Macmillan Co., 1926. 180p. illus. $3.00.

Durand, Herbert. My wild flower garden. N. Y. Putnam's Sons, 1927. 242p. illus. $2.50.

* Findlay, Hugh. Garden making and keeping. N. Y. Doubleday, Page & Co., 1926. 252p. illus. $5.00.

* Free, Montague. Flowers of winter indoors and out. N. Y. Doubleday, Page & Co., 1917. 206p. col. illus. $1.25.

* Jekyll, Gertrude. Color schemes for the flower garden. N. Y. Scribner's Sons, 1925. 159p. illus. $6.50.

Kift, J. L. The woman's flower garden. N. Y. De LaMare Co., Inc., 1927. 152p. illus. $1.00.

* King, Mrs. Francis. The well-considered garden. N. Y. Scribner's Sons, 1927. 234p. illus. $2.00.

* ———. The flower garden day by day. N. Y. Stokes Co., 1927. 210p. $1.50.

Oliver, G. W., and Hottes, A. C. Plant culture; a working hand book of every day practice for all who grow flowering and ornamental plants in the garden and greenhouse. N. Y. De La Mare Co., Inc., 1926. 442p. illus. $3.50.

* Shaw, E. E. Garden flowers of spring, summer and autumn. N. Y. Doubleday, Page & Co., 1917. 3 vols. col. illus. $1.25 a volume. (Pocket garden library series.)

Shelton, Louise. Beautiful gardens in America. N. Y. Scribner's Sons, 1924. 560p. illus. plans. $10.00.

* Sherlock, C. C. City and suburban gardening. N. Y. De La Mare Co., Inc., 1928. 186p. illus. $2.00.

* Singleton, Esther. Shakespeare garden. N. Y. Century Co., 1922. 360p. illus. $3.00.

Wilder, L. W. Colour in my garden. N. Y. Doubleday, Page & Co., 1927. 409p. col. illus. $3.50.

Wright, Richardson. The practical book of outdoor flowers. Phila. Lippincott Co., 1924. 319p. illus. $7.50.

BULB GARDENS

* Rockwell, F. F. The book of bulbs. N. Y. Macmillan Co., 1928. 264p. illus. $3.00.

* Thayer, C. L. Spring flowering bulbs. N. Y. Judd Publ. Co., 1928. 123p. illus. $1.25.

Weston, T. A. Bulbs that bloom in the spring. N. Y. De La Mare Co., Inc., 1926. 144p. $2.00.

ROCK GARDENS

* Farrer, R. J. My rock garden. N. Y. Longmans, Green Co., 1927. 293p. illus. $3.00.

* ———. The English rock-garden. London. Jack, Ltd., 1928. 2 vols. illus. $25.00.

* Rockwell, F. F. Rock gardens. N. Y. Macmillan Co., 1928. 86p. illus. $1.00. (Home garden handbooks.)

* Wilder, L. B. Adventures in my garden and rock garden. N. Y. Doubleday, Page & Co., 1926. 335p. illus. $5.00.

Wright, W. P. Alpine flowers and rock gardens. N. Y. Dodd, 1925. 202p. illus. $6.00.

JAPANESE GARDENS

* Brown, Glenn. European and Japanese gardens. Phila. Coates, 1902. 162p. illus. $2.00.

* DuCane, Florence. The flowers and gardens of Japan, painted by Ella du Cane. London. Adam & Charles Black, 1908. 249p. 20s.

* Harada, Jiro. The gardens of Japan. N. Y. Albert & Charles Boni, Inc., 1928. 39p. plates and col. illus.; $3.00 paper, $4.00 cloth.

Taylour, H. O. (Mrs. Basil Taylour). Japanese gardens. illus. in color by Walter Tyndale. N. Y. Dodd, 1929. 204p., $7.50.

WATER GARDENS

* Bisset, Peter. The book of water gardening. N. Y. De LaMare Co., Inc., 1924. 205p. illus. $5.00.

* Jekyll, Gertrude. Wall and water gardens. N. Y. Scribner's Sons, 1920. 214p. illus. $6.50.

* Sawyer, R. V., and Perkins, E. H. Water gardens and gold fish. N. Y. De LaMare Co., Inc., 1928. 112p. illus. $1.50.

* Tricker, William. Making a water garden. N. Y. McBride, 1913. 51p. illus. 50 cents. (The house and garden making books.) Out of print.

INDOOR GARDENING

* Barnes, P. T. House plants. N. Y. Doubleday, Page & Co., 1927. 242p. illus. $2.00.

* Findlay, Hugh. House plants, their care and culture. N. Y. Appleton, 1916. 325p. illus. $3.00.

Palmer, F. E. Milady's house plants. N. Y. De LaMare Co., Inc., 1926. 176p. illus. $1.25.

* Rockwell, F. F. Gardening under glass. N. Y. De LaMare Co., Inc., 1928. 2d revised edition. 304p. illus. $2.50.

* Taft, L. R. Greenhouse management. N. Y. Judd Publ. Co., 1918. 382p. illus. $2.25.

* Volz, E. C. Home flower-growing. N. Y. Macmillan Co., 1928. 324p. illus. $3.50.

Wright, W. J. Greenhouses, their construction and equipment. N. Y. Judd Publ. Co., 1926. 269p. illus. $2.00.

FLOWER ARRANGEMENT

* Averill, Mary. The flower art of Japan. New edition. N. Y. Dodd, 1927. 216p. illus. $2.50.

White, E. A. Principles of flower arrangement. N. Y. De LaMare Co, Inc., 1926. 225p. col. illus. $3.00.

* Wright, Richardson. Flowers for cutting and decoration. N. Y. Dutton Co., 1923. 218p. illus. $4.00.

INDIVIDUAL FLOWERS

Chrysanthemums

* Herrington, Arthur. The chrysanthemum. N. Y. Judd Publ. Co., 1917. 160p. illus. $1.00.

Dahlias

* Membership in American Dahlia Society, Inc. $2.00 a year.

* Rockwell, F. F. Dahlias. N. Y. Macmillan Co., 1928. 84p. illus. $1.00. (Home garden handbooks.)

Stout, Mrs. C. H. The amateur's book of the dahlia. N. Y. Doubleday, Page & Co., 1922. 314p. illus. $3.00.

Waite, W. H. Modern dahlia culture. N. Y. De LaMare Co., Inc., 1928. 132p. illus. $1.50. (Little book series.)

Delphiniums

* Better delphiniums. San Rafael, Cal. $1.00 a year.

* Macself, A. J. Delphiniums and how to excel with them. O. M. Pudor, Puyallup, Washington. 31p. paper edition. 25 cents.

Gladioli

* Membership in the American Gladiolus Society. $2.00 a year.

* Beal, A. C. The gladiolus. N. Y. Judd Publ. Co., 1927. 124p. illus. $1.25.

McLean, F. T., and others. The gladiolus book. N. Y. Doubleday, Page & Co., 1927. 233p. col. illus. $5.00.

* Rockwell, F. F. Gladiolus. N. Y. Macmillan Co., 1928. 79p. illus. $1.00. (Home garden handbooks.)

Iris

* Membership in the American Iris Society. $3.00 a year.

* Dykes, W. R. A handbook of garden irises. London. Hopkinson, 1924. 250p. illus. $4.00.

* McKinney, E. P. Iris in the little garden. Boston. Little, 1927. 114p. illus. plan. $1.75. (Little garden series.)

* Rockwell, F. F. Irises. N. Y. Macmillan Co., 1928. 84p. illus. $1.00. (Home garden handbooks.)

* Wister, J. C. The iris. N. Y. Judd Publ. Co., 1927. 122p. illus. $1.25. (Farm and garden library.)

Lilacs

* McKelvey, S. D. The lilac. A monograph. N. Y. Macmillan Co., 1928. 575p. col. illus. $18.00.

Lilies

* Fox, H. M. Garden Cinderellas; how to grow lilies in the garden. N. Y. Macmillan Co., 1928. 269p. illus. col. plates, $5.00.

Marshall, W. E. Consider the lilies. N. Y. Marshall & Co., Inc., 1927. 86p. illus. $1.00.

Orchids

* White, E. A. American orchid culture. N. Y. De LaMare Co., Inc., 1927. 227p. col. illus. $4.50.

Peonies

* Membership in the American Peony Society. $3.00 a year.

* Harding, Mrs. Edward. The book of the peony. Phila. Lippincott Co., 1917. 259p. col. plates, $6.50.

———. Peonies in the little garden. Boston. Little, 1923. 91p. illus. $1.75.

Rhododendrons

Cox, E. H. M. Rhododendrons for amateurs. N. Y. Scribner's Sons, 1924. 117p. illus. $1.75.

* Millais, J. G. Rhododendrons. N. Y. Longmans, Green & Co., 1917-1924. 2 vols. col. plates. $130.00.

Roses and Rose Gardens

* Membership in the American Rose Society. $3.50 a year.

* Better flowers; monthly, publ. at North Portland, Oregon. $1.00 a year.

* Hubbard, S. C. Roses and their culture; how to propagate, grow and exhibit outdoor roses in America. N. Y. Judd Publ. Co., 1926. 127p. illus. $1.25.

* McFarland, J. H. The rose in America. N. Y. Macmillan Co., 1926. 233p. illus. $3.00.

* ———. Roses and how to grow them. N. Y. Doubleday, Page & Co., 1924. 151p. illus. $2.00.

* Pemberton, J. H. Roses, their history, development and cultivation. N. Y. Longmans, Green & Co., 1920. 334p. illus. $2.75.

* Pyle, Robert. How to grow roses. Conrad-Pyle Co., West Grove, Pa., 1925. 121p. illus. $2.00.

* Thomas, G. C. Roses for all American climates. N. Y. Macmillan Co., 1924. 251p. illus. $3.00.

* Willmott, Ellen. The genus Rosa. Drawings by Alfred Parsons. London. Murray, 1914. 2 vols. col. plates, $130.00.

PERIODICALS

* American Forests and Forest Life. Washington, D. C. Illus. monthly. $4.00 a year.

* The American Home. Garden City, N. Y. Illus. monthly. $1.00 a year.

* The Flower Grower. Calcium, N. Y. Illus. monthly. $1.00 a year.

* Gardeners' Chronicle. London. Illus. weekly. 30s a year.

* Gardeners' Chronicle of America. New York. Illus. monthly. $2.00 a year.

Gardening Illustrated. London. Weekly. $3.25 a year.

Gartenschönheit. Berlin. Illus. monthly. $5.75 a year.

* Home Acres; the organ of The Woman's National Farm and Garden Association, Pleasantville, N. Y. Illus. monthly. Membership. $2.00 a year.

* Horticulture. Boston. Illus. semi-monthly. $1.00 a year.

* Journal of the Royal Horticultural Society. London. Illus. 7s 6d a number to non-fellows.

* National Horticultural Magazine; publ. by the American Horticultural Society, Washington, D. C. Illus. quarterly. Membership. $3.00 a year.

* National Plant, Flower and Fruit Guild Magazine. New York. Illus. quarterly. 50c a year.

* Revue Horticole. Paris. Illus. monthly. 45 francs a year.

BROOKLYN BOTANIC GARDEN LEAFLETS

* Benedict, R. C. Ferns as house plants. 1922. (Series 10, Nos. 9-10.)

* Free, Montague. Care of the lawn. 1920. (Series 8, No. 9.)

* ———. Epiphytes and house plants. 1927. (Series 15, No. 1.)

* ———. Fertilizers for city gardens. 1918. (Series 6, No. 8.)

* ———. Flowers of the rock garden. 1924. (Series 12, No. 3.)

* ———. Hardy chrysanthemums. 1928. (Series 16, Nos. 8-9.)

* ———. Garden of hardy plants. 1919. (Series 7, Nos. 10-11.)

* ———. Hedge plants. 1914. (Series 2, No. 9.)

* ———. House plants. 1926. (Series 14, No. 1.)

* ———. Naturalized bulbs. 1926. (Series 14, No. 2.)

* ———. Ornamental climbers. 1914. (Series 2, No. 4.)

* ———. Plants for hanging baskets. 1915. (Series 3, No. 3.)

* ———. The rock garden. 1923. (Series 11, No. 6.)

* ———. The small vegetable garden. 1918. (Series 6, No. 1.)

* ———. Some insect pests. 1917. (Series 5, No. 6.)

* Gager, C. S. The Japanese Garden. 1916. (Series 4, No. 5.)

* Graves, A. H. The collection of water lilies at the Brooklyn Botanic Garden. 1921. (Series 9, No. 8.)

* ———. The lotus. 1924. (Series 12, No. 7.)

* Hammond, Elsie. The Wardian case. 1922. (Series 10, No. 5.)

* Reed, G. M. Irises. 1924. (Series 12, Nos. 5-6.)

* Shaw, E. E. Backyard gardens. 1914. (Series 2, No. 1.)

* ———. Bulb culture. 1928. (Series 16, Nos. 8-9.)

* ———. Window boxes. 1914. (Series 2, No. 10.)

WILD FLOWERS AND FERNS

* Baker, M. F. Florida wild flowers. N. Y. Macmillan Co., 1926. 256p. illus. $3.00.

Curtis, C. C. A guide to the trees. N. Y. Greenberg, 1925. 208p. illus. $2.00.

* Durand, Herbert. Wild flowers and ferns in their homes and in our gardens. N. Y. Putnam's Sons, 1925. 394p. col. illus. $3.50.

* Emerson, A. I., and Weed, C. M. Our trees; how to know them. Phila. Lippincott Co., 1918. 295p., plates, $5.00.

* Going, E. M. Field, forest and wayside flowers, with chapters on grasses, sedges and ferns. N. Y. Baker & Taylor, 1899. 411p. illus. $1.35.

* Grout, A. J. Mosses with a hand-lens; a non-technical handbook of the more common and more easily recognized mosses of the north-eastern United States. 2d edition revised and enlarged and including the hepatics. N. Y. The author, 1905. 208p. illus. $3.50.

* House, H. D. Wild flowers of New York. Albany, N. Y. State museum, 1918. 2 vols. col. plates, $7.00; colored plates in portfolio, $2.50.

* Henshaw, J. W. Wild flowers of North American mountains. N. Y. McBride, 1915. 383p. col. illus. $4.00.

* Lounsberry, Alice. Southern wild flowers and trees. N. Y. Stokes Co., 1901. 570p. illus. $5.00.

* Marshall, N. L. Mosses and lichens. N. Y. Doubleday, Page & Co., 1914. 327p. col. illus. $5.00.

* ———. The mushroom book. N. Y. Doubleday, Page & Co., 1923. 170p. col. illus. $5.00.

* Mathews, F. S. Field book of American trees and shrubs. N. Y. Putnam's Sons, 1915. 465p. illus. $3.50.

* ———. Field book of American wild flowers. N. Y. Putnam's Sons, 1927. 610p. col. illus. $3.50.

* Niles, G. G. Bog-trotting for orchids. N. Y. Putnam's Sons, 1904. 310p. col. illus. $2.50.

* Peterson, M. G. How to know the wild fruits. N. Y. Macmillan Co., 1923. 340p. illus. $2.00.

Reed, C. A. Wild flowers east of the Rockies. N. Y. Doubleday, Page & Co., 1926. 228p. col. illus. $1.25.

* Saunders, C. F. Useful wild plants of the United States and Canada. N. Y. McBride, 1920. 275p. illus. $3.50.

———. The Western flower guide. N. Y. Doubleday, Page & Co., 1922. 286p. illus. $1.75.

* Taylor, Norman. A guide to the wild flowers east of the Mississippi and north of Virginia. N. Y. Greenberg, 1928. 357p. illus. $3.00.

Wright, M. O. Flowers and ferns in their haunts. N. Y. Macmillan Co., 1928. New edition. 358p. illus. $2.00.

Periodicals

* Addisonia: colored illustrations and popular descriptions of plants. N. Y. Botanical Garden. Quarterly. $10.00 a year.

* American Botanist. Joliet, Ill. Quarterly. $2.00 a year.

* American Fern Journal; publ. by the American Fern Society. Illus. quarterly. Auburndale, Mass. $1.25 a year.

* Nature Magazine; publ. by the American Nature Association. Washington, D. C. Illus. monthly. $3.00 a year.

* Wild Flower; organ of the Wild Flower Preservation Society, Inc., Washington, D. C. Publ. quarterly by the Ohio Chapter, Cincinnati, Ohio. Illus. $1.00 a year.

Brooklyn Botanic Garden Leaflets

* Benedict, R. C. Conservation of beauty. 1925. (Series 13, Nos. 5-6.)

* ———. How shall we save rare plant species from extinction? 1928. (Series 16, No. 4.)

* ———. Wild plant conservation in Connecticut, a suburban state. 1923. (Series 11, No. 5.)

* Graves, A. H. Arbor Day. 1922. (Series 10, No. 1.)
* ———. Practical suggestions for the growing of Christmas greens. 1928. (Series 16, Nos. 10-11.)
* ———. A preliminary list of native and naturalized woody plants of Greater New York. 1925. (Series 13, Nos. 7-9.)
* ———. What price Christmas greens? 1927. (Series 15, Nos. 11-12.)
* Gundersen, Alfred. Trees of the Brooklyn Botanic Garden and Prospect Park. 1924. (Series 12, Nos. 8-9.)
* ———. The wild flower garden in June. 1917. (Series 5, No. 7.)
* Shaw, E. E. The wild flower garden. 1914. (Series 2, No. 2.)

Ray Simpson.

NOTICES

The Garden may be reached in the following ways: Flatbush Avenue trolley to Empire Boulevard; Franklin Avenue and Lorimer Street trolleys to Flatbush Avenue; St. John's Pl. trolley to Sterling Place and Washington Avenue, Ninth Avenue, Union Street, Vanderbilt Avenue, and Smith Street trolleys to Grand Army Plaza and Union Street; Brighton Beach Express, Broadway (B.M.T.) Subway to Prospect Park (north exit); Interborough Subway to Eastern Parkway-Brooklyn Museum Station.

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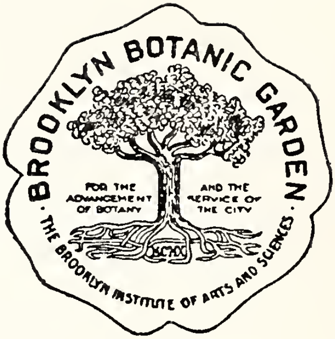
BROOKLYN BOTANIC GARDEN
FOR THE ADVANCEMENT OF BOTANY
AND THE SERVICE OF THE CITY
MCMX
THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

MAY 20 1929

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVII BROOKLYN, N. Y., MAY 15, 1929 NO. 4—5

BIRD LIFE AT THE BROOKLYN BOTANIC GARDEN[1]

A bright, cold day in January, a clear, soft, whistle, and lo! two glossy dark *starlings* on top of a hawthorn tree, on the knoll west of the lily pools. Permanent residents, they may be seen all through the year perched quietly on the topmost branches of some tree, or in flocks walking or hopping on the ground. It was in Manhattan that the starling was first introduced into this country, sixty birds being released in Central Park in 1890, and forty in 1891, and from these one hundred birds the thousands of starlings now dwelling in this part of the country have been descended.

More ubiquitous than the starlings are the *English sparrows,* which make of themselves such pests that effective measures must be taken to prevent their doing grave damage, for example in the experimental plot of the Botanic Garden, where various grains are being cultivated. It may be of interest to recall here that it was at Brooklyn, in 1851, that the first English sparrows were liberated in the United States.[2]

The sparrow family is a large one and includes among its members some charming singers and rare visitors. *Song sparrows,* dearly loved makers of music, unlike their English cousins, are welcome visitors, and may be found in the Garden nearly every week in the year. Those that remain through the winter are usually silent, except for a metallic "click-click," as they slip through the hedges or underbrush. Early in March they begin to sing, and continue, except through the hottest weather, until late in the fall.

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[1] Few people realize the large variety of birds which each year still frequent the Botanic Garden in spite of the rapid growth of the surrounding city. In this LEAFLET, Miss Hammond, who has made a special study of bird life, has given us the benefits of her observations of many years at the Garden. (ED.)

[2] The full account, given by Mr. Nicholas Pike, is as follows: "It was not until 1850 that the first eight pairs were brought from England to the Brooklyn Institute, of which I was then a director. We built a cage for them, and cared for them during the winter months. Early in the spring of 1851 they were liberated, but they did not thrive.

"In 1852 a committee of members of the Institute was chosen for the reintroduction of these birds, of which I was chairman.

The *white-throated sparrows* are plentiful during the spring and fall migrations, and are sometimes accompanied by the *white-crowned sparrow.* They do not mind being closely watched as they scratch about under trees and bushes like small, fussy hens. A few hardy ones stay on through the winter, and have been reported during February when there is so little bird life. About the same time *tree sparrows* have been seen in the Garden; they, however, do not come every year.

The sparrows are soberly clad birds, although one of the family goes dressed in beautiful blue—the indigo bunting. Even here, however, the female with her rather dingy brown plumage shows the sparrow characteristics.

If one is very fortunate indeed he may see in the company of the rowdy English sparrows a much better mannered individual, the quiet little *vesper sparrow,* that rare visitant who betrays his presence in flight by his white outer tail feathers, and whose song, heard late in the afternoon, is sweet and plaintive.

If one watches the common sparrows in winter he is rather apt to see *slate-colored juncoes* in their company, searching for seeds on the ground, or swaying on the tops of dead, dry weeds. The juncoes are birds that like open spaces and are usually on or near the ground. They are very sociable, and travel in flocks. Usually they may be found in the Botanic Garden, but occasionally there is a winter when they do not appear at all.

The *downy* and *hairy woodpeckers,* on the other hand, come during the winter whenever the table is spread for them, or rather when the tree holds a lump of suet. The *chickadees,* too, are fond of this fare and can be coaxed very close to the window of the laboratory building where they may be watched at the feast. Their visits are not confined to winter; they are fairly common in summer, and are then more friendly.

Two other winter visitors must not be forgotten, the *brown creeper,* quietly and efficiently picking insect larvae from beneath the bark of trees, and the *white-breasted nuthatch,* climbing head downward while it searches the tree trunks for insects. These two birds

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"Over $200 was subscribed for expenses. I went to England in 1852, on my way to the consul-generalship of Portugal. On my arrival in Liverpool I gave the order for a large lot of sparrows and song birds to be purchased at once. They were shipped on board the steamship Europa, if I am not mistaken, in charge of an officer of the ship. Fifty sparrows were let loose at the Narrows, according to instructions, and the rest on arrival were placed in the tower of Greenwood Cemetery chapel. They did not do well, so were removed to the house of Mr. John Hooper, one of the committee, who offered to take care of them during the winter.

"In the spring of 1853 they were all let loose in the grounds of Greenwood Cemetery, and a man hired to watch them. They did well and multiplied, and I have original notes taken from time to time of their increase and colonization over our great country." Bur. Biol. Survey U. S. D. A. Bull. 1, p. 17. 1889. Other importations were made in several parts of the country from 1854 up to 1881. ibid. ff.

that are so effective in the protection of our trees leave at the first sign that cold weather will soon be over.

A few *robins* winter on Long Island, but hide in deep thickets and woods, coming out once in a while to gladden winter-weary folk with their promise of spring. Such a bold-hearted red-breast visited the Garden in the middle of last January. Usually the rank and file of robins arrive about the middle of March, and some remain throughout the summer, nesting in the evergreens and other trees. One more venturesome than the rest built her nest inside one of the greenhouses, near the top, and laid her eggs; but either the daily watering was too much for her equanimity, or else she was shut out when the ventilators were closed, for the nest was deserted and no little robins appeared in their strange environment.

During March the birds begin to come back in force—*fox sparrows, flickers, redwing blackbirds,* an occasional *purple finch,* and *purple grackles*—the last, with raucous cries, taking possession of the trees in the Japanese Garden and settling down to the busy work of raising their young.

In the quiet of a March morning, the lake is so peaceful that *Mallard ducks* are induced to fly over from Prospect Park. If one comes early enough he may perhaps see their beautiful irridescent heads; but they are shy, and apt to fly off as soon as they sense the fact that they are being watched. Somewhat later, the black ducks appear. They become so tame that people often fail to realize that they are indeed "wild" ducks. For a number of years a *black duck* has made her nest in the cattails on the south side of the lake, and has proudly led forth her brood each year. On one occasion we counted thirteen young ducklings. In time, alas, the thirteen dwindled to twelve, the twelve to eleven, and, owing to the depredations of water rats and the great bull frogs inhabiting the lake, as well as, sad to say, small boys, the brood grew smaller and smaller, so that only four or five of the young ones reached the age when they were able to fly away. It is always a charming sight to see the old mother duck followed by a line of fuzzy little, brindled ducklings, paddling swiftly over the surface of the lake.

As the spring advances, bird life increases. The friendly little *chipping sparrow* is almost under foot as he hunts for food in the grass around shrubs. The beautiful *cedar waxwings* sit quietly in the tree tops, squeaking like rusty hinges. The *towhee* or *ground robin,* in his neat black, white and brown plumage—brown and white in the female—stops on his way through the city during April or May and industriously scratches up dead leaves under hedges and bushes; while near at hand the handsome *brown thrasher,* recognized by its red brown color and very long tail, slips through the undergrowth or flies across open grassy spaces. The *catbird* comes back to spend the summer in the Garden and can usually be found in company with the brown thrasher in the local flora section in the northwest part of the Garden.

Much harder to see are the *thrushes* and the *oven bird.* Of the former, our regular visitants are the *hermit thrush, gray-checked thrush* and the *olive-backed thrush.* The *veery,* too, that shy little thrush, stops on his way into the heart of the deep woods to the northward, to slip about in the underbrush. Not so shy as the veery is the *wood thrush.* In May or June its lovely plaintive call at the close of day floats out from some secluded spot in the shrubbery to be answered here and there by another of its kind. It stays for a short time and passes on to nest. The *ovenbird* or "teacher bird" comes every May and walks about under the pines or near the wild flower walk as if there were no human beings within miles. But one incautious movement on the watcher's part and the bird is gone. Several times its peculiar song of "Teacher! Teacher!! Teacher!!!", which one usually associates with the deep woods, has come softly out from the pines as though it were too happy not to sing, yet feared to give full voice to its emotions. Its cousin the *water thrush* or "wagtail" may at times be found walking along the edge of the lake or brook, bobbing its tail up and down as it goes.

Another bird that may be seen running along the shore of the lake or by the brook, is the *sandpiper.* Its first appearance is in May, but it returns at intervals during the summer. The lake and the pool at the end of the brook hold a fascination for the belted *kingfisher,* and it is a pretty sight to see him swoop down upon some unwary frog or small fish. Less legitimate as a hunting ground for him are the lily pools, which he loves to watch from the top of the tall smoke stack. A golden shape glides between the lily pads, like a flash of light the kingfisher is upon it and another goldfish has met its doom.

Occasionally the shy *meadowlark* stops for a short time in the early spring but keeps to the grassy slopes of the reservoir where it is protected from prying people by a high iron fence. Its beautiful song floats out and if one watches long enough he may see it rise and may watch its clumsy flight to another spot where it settles down to look for grubs or grasshoppers.

On its way to the country, the *barn swallow* flashes, wheels and dips over the meadow and lake. Its visits are usually confined to the last week of April and the first of May. May is the busiest month of the whole year so far as bird life is concerned. Then comes the handsome *kingbird,* the lovely and rare *rose-breasted grosbeak,* the *goldfinch,* the *phoebe,* the little *pewee,* and sometimes the *blue-headed vireo,* who spends a few days in the Botanic Garden where food is plentiful, and man, though much in evidence, is a harmless creature.

Years ago *bobolinks* were common in this section of the country, but as town and countryside are increasingly built up they become fewer in number. In the late spring this lovely songster sometimes stops in passing.

The smallest of our birds, with the exception of the humming bird, are the *golden-crowned kinglet* who stops on his way north in

February, and the *ruby-crowned kinglet.* The latter, a pretty little fellow, arrives in April and stays on into May. He is generally found among the evergreens or flitting about the plane trees on the hill, searching the lower branches for insects. He is so friendly that one can come very near him, and may have the joy of hearing his sweet little song.

It is in April and May that the host of warblers return to gladden the hearts of bird lovers. These are the birds that fill the air with color and song, life and movement. One day they are here, and perchance are gone the next. Among the first to arrive are the *pine, myrtle* and *yellow palm warblers;* the last two, like the ovenbird, may be found walking about underneath trees and bushes. After the early arrivals the others come in quick succession, the *black and white warbler,* the *black-throated green, black-throated blue* and *Canadian warblers,* the *Maryland yellowthroat* and the little *yellow warbler,* like a canary let loose, flying from tree to tree with its loud cheery call, the shy *prairie warbler,* the *black-poll warbler,* the *redstart* and the charming little *Wilson's warbler,* and handsomest of them all, the *magnolia* and *Blackburnian warblers* never fail to gladden the garden.

By the end of May the warblers have left the city, except those which, like the yellow warbler, nest here. The Garden is not deserted, however, for the busy little *house wren* is bringing up a family, the beautiful *Baltimore oriole* flashes in and out among the trees, and once, at least, the *orchard oriole,* more sombre than its cousin, has stopped in passing. The *sparrow hawk* and the *crow* make periodic visits. The *red-eyed vireo,* a midsummer singer, nests in the Garden, and during the summer that daintiest of birds, the *ruby-throated hummingbird,* like a blossom itself, flits from flower to flower gathering nectar, while in strong contrast the ugly *cowbird* walks on the lawns looking for morsels to its taste; and wheeling high in the air are the *chimney swifts.*

A rare visitor in the early spring, and more common in the fall, the *yellow-bellied sapsucker,* with its undulating flight, and relentless bill, goes from one tree to another, while the *yellow-billed cuckoo,* a good fairy of the woods, flits furtively about. The handsome but far less useful *blue jay* is at no pains to conceal his whereabouts when he comes over from nearby Prospect Park, but poses on some tree in the open; and high overhead sail the *gulls,* always with us, but not among us.

Sometimes the Garden receives some rare or accidental visitors. Once only a *blue heron,* which had probably lost its way, was reported from the lower (terminal) pool; and the *woodcock,* a shy shore bird, visited the Garden one Indian summer day in November. The *mourning dove,* lovely member of a persecuted race, has been seen in the Garden. Other rare birds, some of them mentioned above, are the *vesper sparrow, orchard oriole,* and *blue-headed vireo.* Less rare but not common are the *purple finch,* lovely *rose-breasted* *grosbeak, indigo bunting, red-winged blackbird, Mallard duck,* and *tree sparrow.*

As regards their nesting, most of the birds that come to the Brooklyn Botanic Garden nest elsewhere, but some, even though they are far from the countryside, remain and bring up families. *Robins* nest everywhere; under the eaves of the buildings, in bushes, or in almost any tree. If one follows the *song-sparrows* as they fly into the bushes he will easily find their nests. The *catbirds* raise their young in the shrubbery near the wild flower path in the local flora section, and untidy nests of the *English sparrow* and *starling* are common. The *purple grackles* keep to the evergreens around the lake in the Japanese Garden where with tremendous fuss and bustle their nests are built and the young raised. *Yellow warblers* nest here and there about the grounds, and the *house wren* for some years has raised several families. One *Baltimore oriole* has built its graceful pendent nest on a swaying branch of a gray birch and the always interesting *black duck* has her home among the cattails in the lake.

It may seem strange that all these birds, and more—for this is not an exhaustive list—should come to the Brooklyn Botanic Garden, set as it is in the heart of a great city, and so near to that bird sanctuary, Prospect Park. But birds are friendly creatures, ready to go wherever they are welcomed; and in this place there are open spaces, wooded nooks, a lake and brook dear to bird life, no noisy motors, and an abundance of food. No wonder that birds love the Brooklyn Botanic Garden and that the Garden shelters them.

Following is a list, compiled from yearly records, of birds seen at the Brooklyn Botanic Garden:

BIRDS SEEN AT THE BROOKLYN BOTANIC GARDEN

Blackbird, Redwinged
*Blue Jay
Bobolink
Brown Creeper
Bunting, Indigo
Catbird
*Chickadee
Chimney Swift
Cowbird
*Crow
Cuckoo, Yellow-billed
Duck, Black
“ Mallard
Finch, Purple
Flicker
*Goldfinch
Grackle, Purple
Grosbeak, Rose-breasted
Gulls
*Hawk, Sparrow
Heron, Blue
Hummingbird
Junco, Slate-colored
Kingbird
Kingfisher
Kinglet, Golden-crowned
“ Ruby-crowned
Maryland Yellowthroat
Meadowlark
Mourning Dove

*Nuthatch, White-breasted
Oriole, Baltimore
" Orchard
Ovenbird
Pewee
Phoebe
Redstart
Robin
Sandpiper
Sparrow, Chipping
* " English
" Fox
* " Song
" Tree
" Vesper
" White-crowned
" White-throated
*Starling
Swallow, Barn
Thrasher, Brown
Thrush, Gray-cheeked
" Hermit
" Olive-backed
" Veery
" Wood
Towhee
Vireo, Blue-headed
" Red-eyed
Warbler, Black and White
" Blackburnian
" Black-throated Blue
" Black-throated Green
" Black-poll
" Canadian
" Chestnut-sided
" Magnolia
" Myrtle
" Palm
" Pine
" Prairie
" Wilson
" Yellow
Water Thrush
Waxwing, Cedar
Woodcock
*Woodpecker, Downy
* " Hairy
Wren, House
Yellow-bellied Sapsucker

* Those with an asterisk are classed as permanent residents in this vicinity.

For the benefit of teachers who may wish to obtain bird pictures or charts, the following list is appended:

National Audubon Societies, 1974 Broadway, N. Y. C.

Joseph Dodson, Kankakee, Ill. (The Mumford Prints.)

Church and Dwight Co., 27 Cedar Street, N. Y. C. (Useful Birds of North America.)

Charles K. Reed, 238 Main Street, Worcester, Mass. (Postal cards, natural colors. Miniature pictures.)

Coca-Cola Co., Atlanta, Ga.

American Nature Association, 1214—16th Street, Washington, D. C. (Bird and Animal Paintings by R. Bruce Horsfall.)

ELSIE TWEMLOW HAMMOND.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVII BROOKLYN, N. Y., NOVEMBER 6, 1929 No. 6–7

EVOLUTION AS ILLUSTRATED BY FERNS*

Seventy years ago, Charles Darwin wrote into the minds of men at large the idea that similarities between existing species of plants and animals indicate relationships, for which further convincing evidence may be found in the geological series which constitute the genealogical records. Expressed in other words, he established firmly the idea that creation has been, and still is, a process of continuous evolution. At first, many refused the new thought as contrary to old, accepted beliefs and teachings. Today, on the contrary, it is a matter for wonderment when someone, supposedly intelligent, rises to attack the accepted faith in the law of evolution; and we place together, intellectually, the anti-evolutionist and that other, who declared (according to a recent news item) that the earth is flat and that the sun revolves about the earth.

It should be emphasized here that while Darwin is responsible for the general acceptance today of evolution, the idea did not originate in his mind, but had been thought of from time to time since the days of Aristotle. Darwin's contribution was a description of a workable method, that of natural selection, by which species may have been differentiated. As evidence of this method, Darwin presented an overwhelming mass of facts, the result of over twenty years of world-wide travel and intensive study.

Today, evolution is a commonplace in the minds of those who view the facts with open minds, and is as well established as the fundamental laws of chemistry and physics; as well as our ideas of molecules and gravity, and resting on the same basis of reasoning; namely, the inferring of causes from activities and results.

Ferns supply ample evidence of evolution along the lines on which Darwin originally worked; of similar and related species, and of continuous geological lines of progress, extending far back into the coal period, much earlier than the line of any other of the larger land plants. It is a matter of great significance that to those fern relatives of primordial forests we may trace the ancestry not only of modern ferns but also of practically all the common and important flowering plants of today. It is a matter of more than passing interest also that to these same primitive ferns we owe in large part our coal and mineral oil supplies of modern industry.

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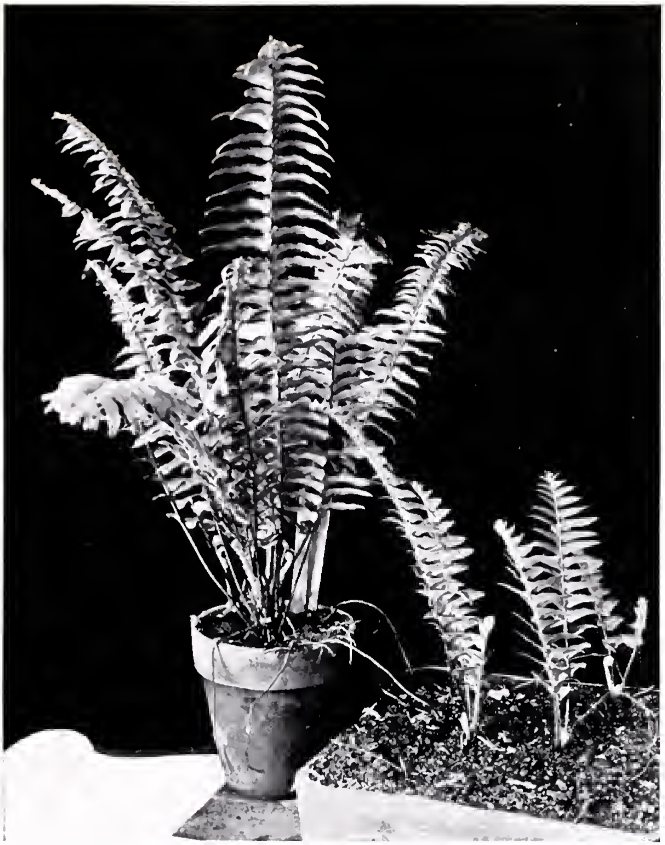
* This LEAFLET is a reprint, with revision and additions of Series X, No. 3, 1922.

Within the last twenty-five years there has grown up among scientists a desire to add to the comparative and geological evidence of evolution that of experimental proof. If plants and animals of today have really arisen from those of yesterday, as the geological record indicates, it should be possible somewhere and somehow to detect a species in the act of origin. It should even be possible to examine the specific causes which may lead to the appearance of new forms, and perhaps to control or guide these causes so that new species might be produced at will. With these aims in view, the last three decades have seen increasing attention paid to the study of experimental evolution, and in the course of this time, much controversy has arisen regarding the minutiae of the evolutionary process. In some of these disagreements the anti-evolutionist has thought to find the basis for refuting the whole theory, misunderstanding the relative insignificance of the disputes as to methed.

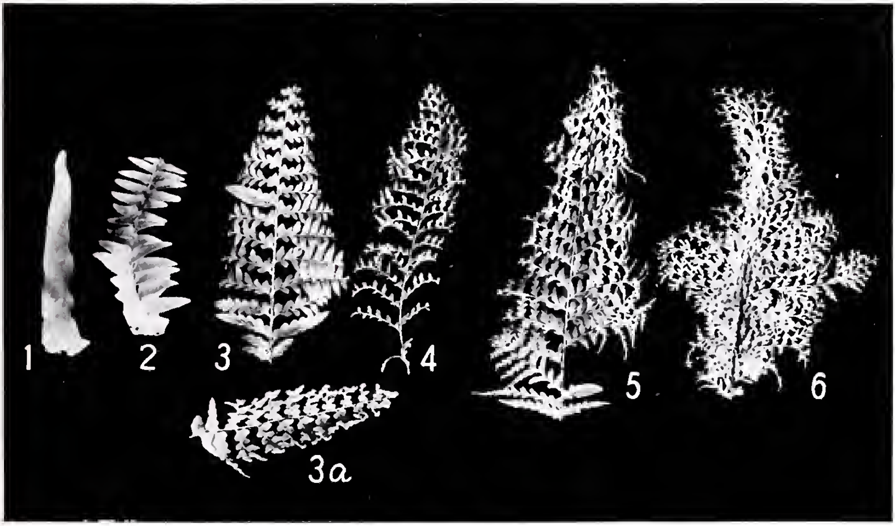
What have been the results of this experimental study? Have new species been seen in birth? Have they been experimentally produced? The answer hinges upon the definition of the term "species." It will be worth while to consider in an elementary way just what is meant by a species. Probably no two scientists agree exactly upon the definition of the word species, but it will not be necessary here to go into the details of the difficulty. It is, perhaps, sufficient to say that a given species includes all such individuals which, in plants, resemble each other so closely that they might have been raised from the seeds or spores of one parent plant of non-hybrid origin.

What experimental evidence can ferns offer relating to the appearance of new species? We may answer this best by consideration of the history of the common house plant known as the Boston fern. Up to about 1895 one of the common ferns of the commercial greenhouses was the so-called sword fern (*Nephrolepis exaltata*), common in Florida and in the tropics, and reasonably uniform in its characteristics wherever found. It had been cultivated by florists for about a half a century and had come to be rather common about thirty-five years ago. About that time a florist near Cambridge, Massachusetts, found among his sword ferns a new sort, in many respects like the sword fern, but differing in several particulars which made it a better house plant. For example, its leaves were softer and more graceful, and it produced more leaves in a pot of a given size, making a more compact, bushy plant. Becker, the florist concerned, thought he had a species entirely different from *exaltata* and sold it at first under the name of another known form. Later, the error was corrected, and the Boston fern, as it came to be known, was distributed very widely among florists, and grown in increasing numbers until the annual production reached many hundreds of thousands of plants.

As thus grown throughout the country, the Boston fern remained the same, and plants from the southern states, and from the western, northern, or central part of the country, could not be distinguished from those of eastern Massachusetts. Six exceptions to the above



Text Figure 1.—A parent plant and three vegetatively produced offspring, of the wild sword fern. By variation, one or more would differ from the parent.



Text Figure 2.—Variation in leaf division. Pinnae of seven distinct forms: (1) Boston fern; (2) Piersoni; (3) Whitmani; (3a) Amerpohli; (4) Magnifica; (5) Smithi; (6) Craigi.

statement must be noted. Within a few years of each other, there appeared in the greenhouses of commercial growers in five states, amid countless thousands of normal Boston fern plants, six new varieties, sports, or mutations; in other words, different kinds of ferns. It is of interest that these six new ferns may be grouped in three pairs, representing three kinds of differences, as compared with the Boston fern.

Here in Brooklyn, in the greenhouse of John Scott, there appeared one form which differed from the Boston fern in being smaller, about two-thirds as long, and with the leaf divisions (pinnae), somewhat curved and rolled. In New Jersey, in the greenhouses of George Giatras, there appeared another smaller form, not more than half the length of the parent form, and with other differences making it even more distinct. Each grower named his variety after himself, as is the trade custom, and so we have the Scott fern and the Giatras fern.

In Massachusetts, and in Tarrytown, New York, another pair of new varieties was found, which differed from the Boston fern in having the leaves divided twice instead of once; *i.e.*, each lateral division was again divided, making each like a miniature leaf complete in itself. The Tarrytown fern was called Piersoni, after its introducer, and the Massachusetts fern similarly was designated the Foster fern. Although alike in the amount of leaf division, they differed considerably in particulars of growth and shape of leaflets.

The third pair of new forms differed less from the Boston fern and from each other than those already mentioned, but were yet entirely distinct and recognizable. In both cases the leaves showed an increase in ruffling, *i.e.*, instead of being nearly flat and plane, the lateral divisions (leaflets or pinnae) were much fuller and somewhat ruffled, making a more beautiful leaf. Between these two new varieties, called respectively the Harris fern after its discoverer, a Philadelphia florist, and the Roosevelt fern, produced in Ohio, the main difference was a matter of size.

On these six forms the case of evolution might well be rested. They are not strictly "species," although perhaps four of them offer sufficient differences to justify separation. In common with the parent Boston fern, these new forms are able to reproduce only by runners. Whether or not, if they had originated in nature, they would succeed as species under wild conditions, it is at present difficult to judge. It would be most interesting if an experiment on a large scale in some Florida woods were feasible; if, for example, colonies of several scores of plants of each of the different new forms could be set out under wild conditions and left for a year or more. It may be added, incidentally, that although there is possible doubt as to the survival value of these original Boston fern varieties, there is in the collection at the Brooklyn Botanic Garden another series of new forms, which have had their origin there, and about whose fitness to survive there can be no possible doubt.

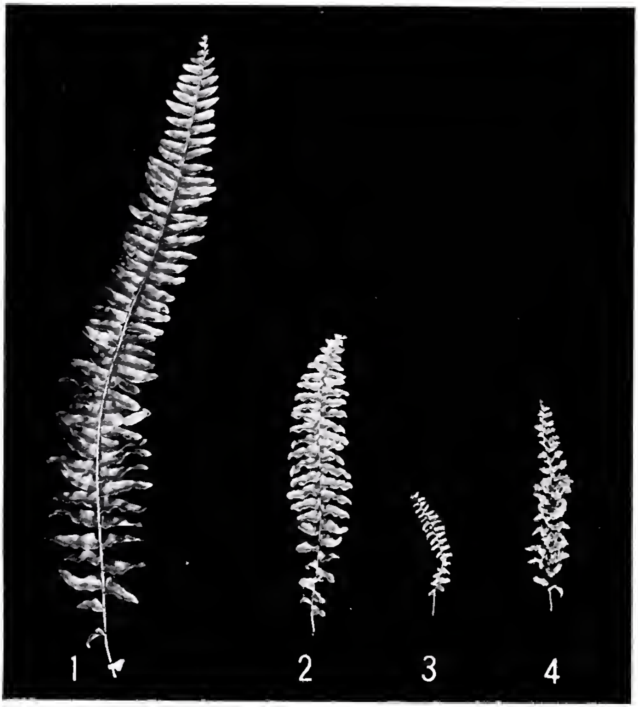
These six Boston fern varieties just referred to illustrate two of the aspects of evolution even if their claims to consideration as actually demonstrating evolution may be doubted. Evolution contravenes heredity. According to the laws of heredity, the original sword fern should have produced only sword ferns, but the Boston fern appeared as something different. Again, according to heredity all Boston ferns should forevermore have produced only Boston ferns, but there are at least the six exceptions described above. The second point to be noted is the fact that evolution is none the less only the rare exception to the law of heredity. Probably more than twenty-five million Boston ferns have been grown and sold within the last thirty-odd years, but in that time only six certain exceptions to heredity have come to life.

Heredity conserves the old or existing types. Evolution produces something new, different from the old, but how or why, no one can really say with certainty. What determines whether a new form so produced shall continue to exist? Under conditions of civilization, survival value depends on utility, practical or decorative, to man. Man selects from among wild ferns those forms most desirable in his eyes, and most easy to grow. From among their variations, he has selected those new forms which further possess the same qualities. Nature, on the other hand, demands not necessarily beauty of form, but, among other qualities, particularly vigor of growth, and ability to survive adverse conditions.

A differentiation between the natural and artificial selective methods may be postulated in the case of the development of the races of domesticated and wild canine forms. Some savage—more than once it must have happened—finding a den of wolves, made captives of the young as playthings. Sometime, among such a captured litter, there must have occurred at least one puppy more susceptible of taming, which liked captivity, and came to depend on its human captor for protection. Many wolf puppies have been captured, and more or less tamed, but generally less, because it is a hereditary characteristic that the average wild animals shall distrust confinement, and resist taming. The rare variation, the tameable wolf puppy, would delight the man captor, and in time it might add its value as protector of the household, warning off its former associates. But what would be the fate of such a milder, less ferocious puppy under wild conditions? To ask is to answer. Nature does not seem to have selected wolves on the basis of mildness and tameableness.

To apply the conclusion of the foregoing: from the Boston fern there have developed variations which answer the test of specific differences as far as distinctiveness is concerned. Whether they would all survive under natural conditions remains to be tested. Some variations, however, have been found, and have occurred at the Brooklyn Botanic Garden, which answer the difference test, and would undoubtedly survive under the conditions of natural selection.

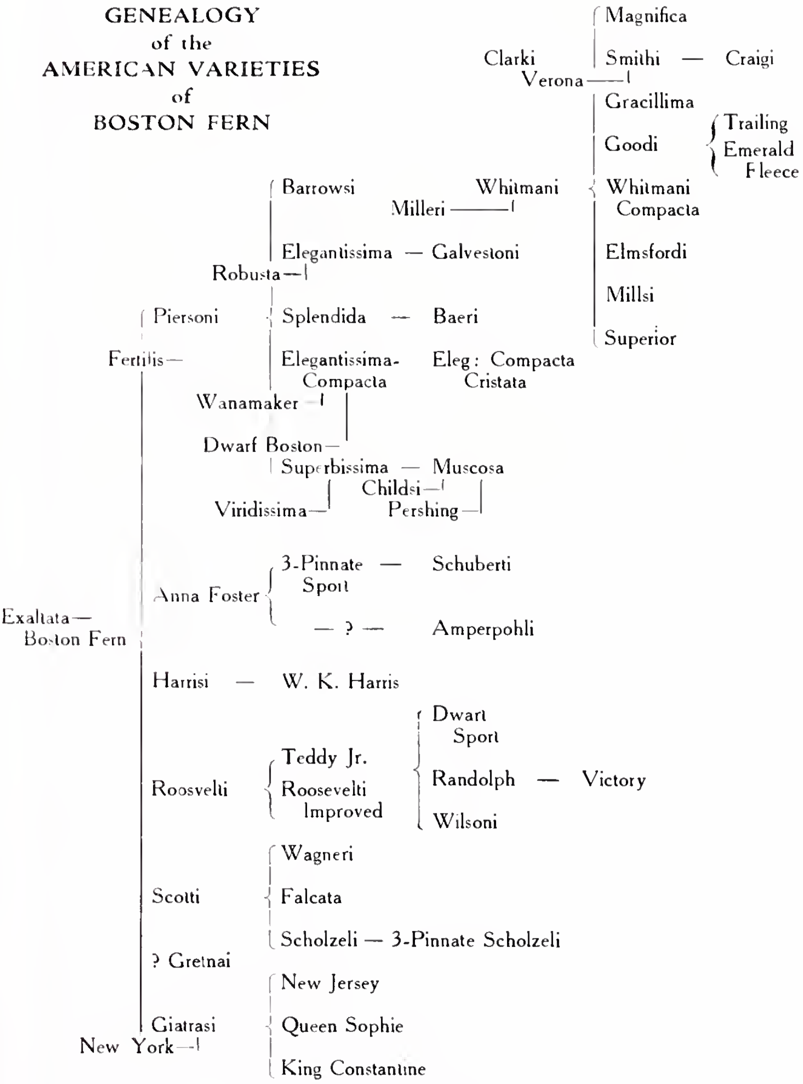
But the Boston fern has gone much further along the lines of demonstrating evolution than merely producing six distinctive new forms. Each of these has continued the process. While remaining constant in their own characteristics, following the law of heredity in the great mass of progeny, each of the six cited above has given rise to new forms, well distinguished from their parents, and like them able to breed true, *i.e.*, they are variations of the kind called mutations. Two illustrations will suffice. From the Pierson fern, itself twice divided, has come the Barrows fern, somewhat smaller and more consistently twice divided. From the Barrows fern has come the Whitman fern, three times divided. From the Whitman fern has come the Smith fern, four times divided, and lacy; and from this, an apparent end to this line of progression, the five times pinnate Craig fern. Similarly, from the Giatras fern has come another type accentuating the reduced size, a dwarf variety less than one-sixth the size of the original Boston fern, named, as it happened, the New Jersey fern. From the original ruffled forms, have come new forms with a greater degree of ruffling; from divided varieties there have appeared dwarf divided forms. It appears that these types of variatian may be shuffled and redealt in almost endless permutations and combinations. The result is that within about twenty years, Ameri-



Text Figure 3.—Leaves showing variation in size. (1) Boston fern; (2) Giatrasi; (3) Dwarf sport of Giatrasi; (4) Queen Sophie, 2-pinnate sport of Giatrasi.

can florists detected and named probably seventy-five distinct variations, from some one of the forms first separating from the Boston fern. The total number of forms which have appeared, many not named, undoubtedly exceeds two hundred.

With the exhibit of Boston fern varieties in House 10 of the conservatories at the Brooklyn Botanic Garden a chart is installed at the entrance which shows in a graphic way the genealogical tree of the different varieties as follows:



In diversity of form, size, growth characteristics—in other words—in criteria which are used to separate species of the wilds, these new forms have exceeded the limits of variations among the wild species of *Nephrolepis*, the leaves of all of which are only once divided, and often hard to differentiate. Recently there have come to my attention forms of the Boston fern series in which the leaves reproduce new plants, besides forms with corkscrew twists in the leaves, and also forms showing other types of variation extraordinary for this genus.

The multiplicity of different types of variation is interesting, but even more so is the fact that along the main lines of variation, leaf division, dwarfing, and ruffling of leaves, there have appeared such consecutive series, in which each of these characters has been intensified. Such series of variations are called *orthogenetic*, and there is a growing belief among students of evolution that orthogenesis, so called, or in other words, evolution in a definite direction, must be accepted to account for many of the phenomena of variation evident, both in fossil forms and in present day groups of species. (See Chart, page 7.)

Both as regards orthogenesis, and as regards the presentment of definite new forms, recently evolved, the Boston fern offers evidence without precedent among other groups of plants and animals. The ultimate status of these new ferns as "species" must be left open for further study.

R. C. BENEDICT.

An exhibition of about seventy-five varieties of the Boston fern is installed in House No. 10 of the conservatories of the Brooklyn Botanic Garden. This is practically the same collection as the one displayed by the Garden at the exhibition of the Massachusetts Horticultural Society in Boston, where the officers of the Horticultural Society created a special prize and awarded a gold medal to the Brooklyn Botanic Garden on account of the unusual excellence of the collection.—ED.

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BROOKLYN BOTANIC GARDEN
LEAFLETS

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FORMS AND FUNCTIONS OF STEMS[1]

Shoot and Root.

No matter what seed plant[2] we select, whether it be a tall tree, a sunflower plant, or a tiny grass plant, its vegetative organs—those principal parts of its make-up which enable it to *vegetate* or grow—are of only three kinds: leaves, stems, and roots. Leaves and stem are also comprehended under one term, the "shoot." These relationships may be represented as follows:

Vegetative Organs of Seed Plants

$$\left.\begin{array}{l}1.\ \text{Leaf}\\2.\ \text{Stem}\end{array}\right\}=\text{Shoot}$$

3. Root

All the leaves, stems, and stem branches of any one plant are often designated as its "shoot system," and *all* its roots and their branches as its "root system."

What constitutes a true "stem?"

It is a common mistake to refer to the petiole or stalk of a leaf as its "stem." This is rank heresy against morphological canons, for the petiole is not a stem structure at all, although, indeed it may possess one of the attributes of typical stems, being usually cylindrical in form. The petiole is merely *part of the leaf*. To the plant morphologist the term "stem" has a special meaning; it should be applied only to those parts of the plant which are truly stem structures. Since in outward appearance a stem structure may undergo extensive transformations when it assumes special functions, how are we to know for a certainty whether or not a given part of a plant is really a stem structure? In order to do this we must examine it from the following points of view.

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[1] This Leaflet is intended as a companion issue to Series XIV, No. 9-10, "Forms and functions of leaves," and like the latter has been prepared primarily for the assistance of teachers and students of botany and biology who visit the Brooklyn Botanic Garden for the study of stems and stem structures of seed plants as a special project. Accordingly, it aims to describe briefly the various forms and functions of stems, using as examples, as far as possible, specimens growing in the conservatories and outdoor plantations of the Brooklyn Botanic Garden. It is suggested that the student be provided with a note book of unruled paper in which drawings and independent observations of the various structures may be entered.

[2] By "seed plant" we mean a member of the highest group of plants—those that bear seeds. This group includes those commonly known as "flowering plants" as well as those whose seeds are borne in cones as in the pine family, together with the plants classified near the pines, such as the yew, ginkgo, and cycads.

1. The *position* of an organ with relation to the other parts of the plant is an important consideration. The thorns of the hawthorn arise in the axils of the leaves, and since only stem structures arise in leaf axils, merely the fact of their position is strong evidence that the thorns in this case are modified stems.

2. We must observe what organs or structures the part in question bears or produces. Stems may bear leaves, buds, flowers, and roots—in fact, stems can regenerate all vegetative parts of the plant, as those who are trying to rid the soil of poison ivy, bindweed, twitch or quack grass, etc., by cutting the stems into pieces, learn to their grief. The leaf-like branches of the butcher's broom (*Ruscus aculeatus*) bear flowers at about their central portion, proving that they are modified stems. Although they are leaf-like in appearance they can not really be leaves, since leaf structures never bear flowers.[3] The thorns of the hawthorn in species such as *Crataegus compta* and *arnoldiana* usually bear a bud at their base during the first year. This in later years may develop into a short shoot.

3. *Comparative morphology*. A study of corresponding structures in related plants is often an aid to a correct determination of the nature of a given structure. Taking again as an illustration the case of the thorn of the hawthorn, we find that in at least one species, the English hawthorn, *Crataegus oxyacantha,* a few rudimentary leaves are produced before the growth ends in a thorn. In the common pear (*Pyrus communis*), a closely related plant, the leafy short or spurshoots often end in thorns, and moreover all gradations occur from this short, leafy shoot terminating in a thorn to the simple thorn. A similar condition exists in the plum, another related species.[4]

4. *Ontogeny* (individual development). A study of the early developmental stages of an organ may throw light on its true nature. For example, the early stages of a stem structure show (in most cases) the vegetative cone or growing point characteristic of an embryonic stem apex.

5. *Anatomy*. The internal structure of the organ in question, the kinds and arrangement of tissues may, though by no means always, be used as an aid to a determination of its true nature. The arrangement of tissues in the potato tuber, for example, is that characteristic of stems and not of roots. This in itself is evidence of the

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[3] Goebel notes an exception in the case of species of *Utricularia.* Organography of Plants, Pt. 1, p. 15.

[4] Experimental morphology may also be called into play. For example, if, at the right time, one cuts off the long shoot at a point just above the short shoot which was destined to become a thorn, this short shoot may be compelled to become a long, leafy shoot instead of a thorn.

stem nature of the tuber, aside from the fact that it produces buds in the "eyes" and short scale leaves below each eye.[5]

Before proceeding to more specialized stem forms let us consider first the characteristics and functions of ordinary stems.

I. TYPICAL FOLIAGE-BEARING STEMS

1. *General characteristics.* In *form* the typical stem is tapering-cylindrical, as is consistent with its principal function of support, the main stem growing erect in the air, the branches being more or less horizontal. In *color* stems are usually green when young, thus helping in the work of food making. With age they assume various colors—in the case of woody stems, mainly browns or grays. As to their *texture* stems may be either herbaceous or woody. Herbaceous stems are comparatively soft and die down to the ground in the fall, either the whole plant dying out entirely as in *annual* plants, or the aerial stems dying down to a subterranean stem which lives through the winter as in *perennial herbs* like Solomon's seal, aster, goldenrod, etc. Woody stems, characteristic of trees, shrubs, and some climbing plants like poison ivy and woodbine, remain alive above ground throughout the winter. These are *woody perennials*, adding to their length and thickness during each season of growth. Since these plants usually support a far greater number of leaves than herbaceous plants, and since they must endure all vicissitudes of the weather, their stems are of necessity stronger.

The stem and its branches are divided into *nodes*, which are the places where leaves are borne. The parts of the stem between the nodes are called *internodes*.

The arrangement of leaves on a stem follows a particular plan characteristic of the kind of plant concerned. In some plants the leaves are opposite each other on the stem; in others, alternate, in which latter case a spiral arrangement obtains.[6] On account of this constancy of leaf arrangement in each species, the branches which arise from the buds in the axils of the leaves have also an entirely regular arrangement, a condition which is quite different from the irregular branching which occurs in roots, although it is true that in the very young portions of the root the branches are borne in regular vertical rows.

As to *external markings*, the green or herbaceous stem, except in particular cases, has no characteristic ones. But a woody stem, especially a younger branch or twig, shows in winter many interesting "trade-marks" which proclaim the nature of its business. The tiny dots appearing here and there on the surface of the young twig mark the spots where the *lenticels* occur—small masses of rather loose tissue, between the cells of which there is opportunity for an interchange of gases between the interior and the outside world. When the leaves drop off, a scar known as a *leaf scar* remains on the twig, marking the place of attachment, and when stipules occur they also leave scars. At the end of each year's growth of the twig in length, a close series of irregular ring-like scars marks the spot where the bud-scales dropped off; and by counting the successions of these ring-like areas one may estimate the age of the twig.

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[5] These scale leaves soon atrophy, leaving only a scar, the "brow" of the mature eye. See Artschwager, Ernst. Studies on the potato tuber. *Jour. Agric. Research* **27**: 809-835. pls. 1-10, text figs. 1-8. 1924.

[6] This subject of leaf arrangement or *phyllotaxy* is fully explained in most botanical textbooks. See Smith, Overton, Gilbert, Denniston, Bryan and Allen. *A textbook of general botany.* Rev. ed. pp. 85-87. 1928.

Typical stems (and roots also) differ from leaves in possessing an unlimited type of growth. Leaves, once fully developed, grow no further[7]; but stems continue their growth from an apical growing point which develops new stem tissue as well as new leaves. There are, it is true, special stems of limited growth, as in the short spurs, most noticeable in cherries, birches, pines, larches, gingko, and others, but as stated above, by cutting off the branch or stem just beyond these short shoots they may be compelled to develop the next year into long shoots. Often they do this of their own accord, influenced perhaps by changing conditions of light or nutrition.

These characteristics of typical foliage-bearing stems may be summed up as follows:

1. Erect in the air.
2. Cylindrical in form.
3. Color green in herbaceous stems; brown, gray, etc., in woody stems.
4. Texture firm in herbs; hard in woody stems.
5. Divided into nodes and internodes.
6. Regular branching.
7. Young woody stems show bud-scale scars, leaf scars, lenticels and buds (besides nodes and internodes).
8. Unlimited type of growth.

2. *Functions.* In a consideration of the stem, we must bear in mind that the leaf is after all the most important vegetative organ, for here is the laboratory where the raw materials are made into plant foods, and each laboratory, in order that it may function properly, must be adequately supplied with energy from the rays of the sun. It is therefore of the greatest importance to the plant that these flat plates composed mainly of green tissue, and otherwise known as the "leaves," be so disposed that they will receive the sun's rays to best advantage. Therefore they are strung along an axis—the stem—at such distances apart and at such angles that they shade one another as little as possible. First of all, then, the stem functions simply as an axis for the support of the leaves. The larger the plant (of a given species), the more leaves for food-making must it have, and vice versa. And so we may think, for example, of a

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[7] The leaves of *Welwitschia mirabilis,* the Tumboa, a remarkable African plant, furnish the most notable exception to this rule. These leaves, two in number, and the only ones the plant possesses, continue to grow from a basal zone throughout the life of the plant, sometimes for 100 years.

mighty oak tree as after all nothing more than an enormous stem (if we except the roots), with its trunk, main branches, branchlets and ultimate twigs, all for the purpose of the display of its thousands of leaves (and flowers as well) borne on the new growth of the year. In order to do this year after year, sometimes for centuries, it must be strong enough to endure gales and storms, and the snows and ice of winter.

But the leaves also require mineral salts and water from the soil, and in addition, the foods which they prepare must be carried to other parts of the plant. So that besides its function of support of the leaves, the stem also conducts to and from them, liquids of various kinds. To these two functions of a typical stem a third should be added, namely, the bearing of the reproductive organs (flowers, fruit and seed) at the apex of the stem or its branches.

A fourth function that is often subserved by typical stems is the storage of food. Especially is this true of woody stems, whose unfolding and development of young leaves from the buds in the spring depend upon the amount of ready food supplies available. Large quantities of starch are stored in trunks, branches, and twigs during the late summer in preparation for this activity. With the approach of spring, enzyms or ferments change this starch to sugar, in which soluble form, along with other foods, it is easily transported from cell to cell. Then the sap has a sweet taste, and among others the sugar maple has an especially rich content of this sweet sap in the spring—nourishment on its way to answer the hurry call of the tiny young unfolding leaves in the bud, unless diverted into the pail of the maple-sugar orchardist.

These functions of a typical stem may be summarized as follows:

1. To support the leaves.
2. To conduct liquids.
3. To bear the reproductive organs (flowers, fruit and seed).
4. To store food (in many cases).

II. FOLIAGE BEARING STEMS WITH SPECIAL MODIFICATIONS.

In the following kinds of foliage-bearing stems, the climbing and creeping sorts rely on some outside support—trees, walls, or mother earth herself. For this reason they are not called upon to construct such firm nor thick tissues as the erect stem, and this is of course on the side of economy. In the case of the "traveling" stems we find, in most cases, specially formed branches in addition to the typical erect stems. These either grow along the surface of the ground or bend over to it, taking root at a distance from the parent plant, thus furnishing a means of vegetative reproduction. These various forms will be taken in order.

a. Climbing Stems.

1. *Clamberers.* Some plants simply lean or clamber over other plants or rocks. They possess no specially modified organs to enable

them to do this except for adventitious roots or sometimes thorns. Often these clamberers may climb high trees, or again, if such erect supports are lacking, simply ramble over walls or the ground. The Poison Ivy (*Rhus toxicodendron*) is a plant of this type, and may be seen near the border mound just north of the service gate in the southwest part of the Brooklyn Botanic Garden. Another excellent example is the Ceriman (*Monstera deliciosa*). This interesting plant, a native of tropical American forests, can become on occasion a high climber, if large trees for suitable supports are conveniently near at hand; or, as in the Economic House of the conservatories, it can clamber with its stout, sinuous stems in a very expert fashion over rocks and walls. It drapes itself over the high rock wall at one side of the pool in the Economic House, forming a loose mat of tangled dark green stems from one to two inches in diameter with abundant adventitious roots, many of which dangle in the water of the pool—while others seek the crevices of the rocks and still others hang loosely from the stems. With its large, cleft and perforated leaves and its edible fruit, like a pine cone in appearance and of a flavor that is a cross between pineapple and banana, it is one of the most attractive features of the central conservatory. Plants of this sort, which are abundant in the tropical forest, particularly in so-called "rain forests," come under the rather general heading of *lianas* or lianes, a term which includes also stem twiners. (Figure 1.)

In House No. 3, in the northeast corner, the Purple Wreath, *Petraea volubilis*, from tropical America, is another good example of a plant which is a clamberer, or a high climber, according to the facilities at hand. Its long, wand-like stems wrap themselves loosely about supports, without the close spiral method of the typical twiner. In the opposite corner of this house *Allamanda cathartica* var. *Williamsii*, with its long, weak stems, illustrates well the same characters; as does also *Norantea guianensis* from South America, growing from a pot on the central bench in House 4: having reached the gable of this house it extends laterally underneath the roof as far as each end. In House 11, on the east bench, one may see a clamberer that holds on by means of its thorns—the New Zealand Bramble, *Rubus australis*, a member of the blackberry tribe. In its native habitat this is a "lofty climber, abundant on the edges of woods." Its thorns are "emergences," i.e. simply outgrowths on the petiole of the leaf and its branches, the leaf blades being often reduced to the merest tiny flecks of green at the tips of the almost naked veins. In the outdoor plantations, along the east bank of the lake, and also on rocks on the high bank at the north end is another fine example of a "thorn clamberer," *Rosa wichuriana* from Japan. Of course any number of these thorn clamberers may be seen in the Rose Garden. Among other plants that may be referred to this category is the Rangoon Creeper, *Quisqualis indica*, a native of the Malay Peninsula, which may be found in the Economic House near the door to House 6. This has a peculiar type of thorn, in reality the persistent basal portion of the

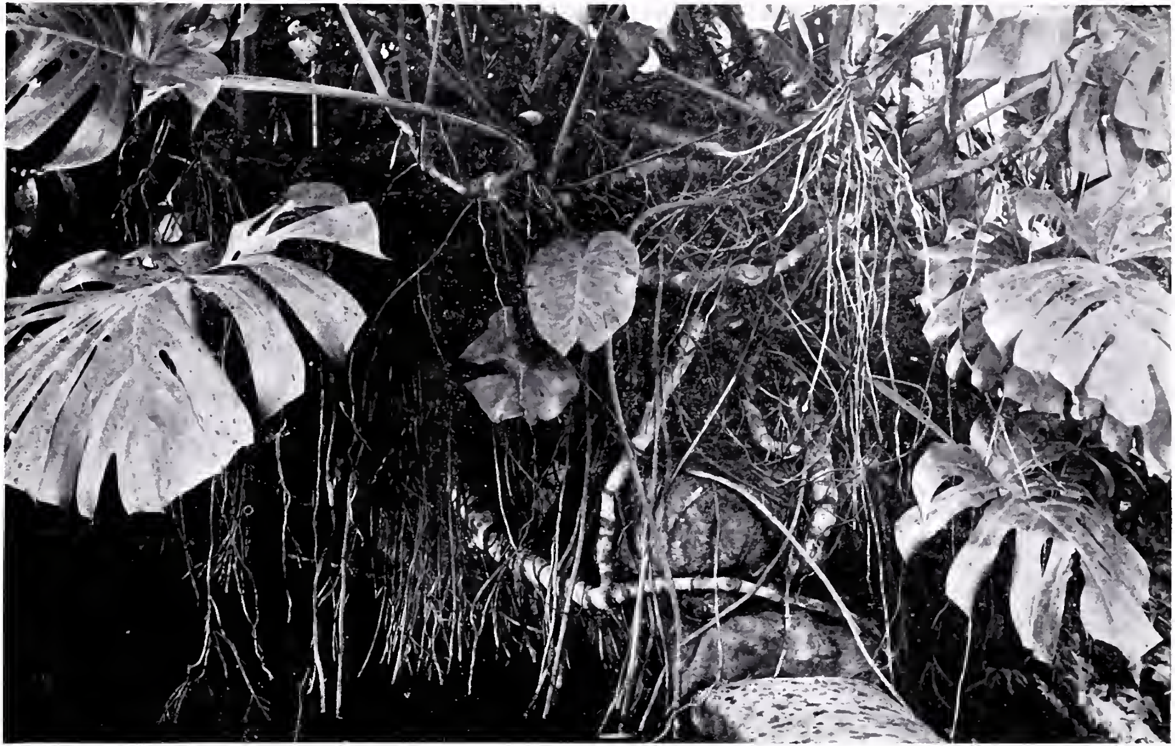

FIGURE 1. A typical clamberer, the Ceriman, *Monstera deliciosa*, of the Arum Family, a native of the American tropics, with edible fruit. This photograph shows the habit of the plant as it grows in the large central conservatory or Economic House of the Brooklyn Botanic Garden. Note the characteristic way in which the stems wrap themselves around the stones in the wall at the end of the pool (shown at the left, below).

leaf petiole, as explained in the former Leaflet.[8] Since the leaves are opposite, these persistent stubs of the petioles appear like rungs along a single-pole ladder, and the whole is very effective as a means of catching on and holding fast to other vegetation. On the left, as one comes in at the main entrance to the conservatories, is *Vanilla planifolia*, a climbing orchid whose seed pods yield the well-known valuable flavoring. This plant, a native of Mexico and Central America, climbs by means of its adventitious roots, which develop at each node, as well as by its twisting stem, thus ascending to a height of many feet.

2. *Clingers*. For the purpose of classification we may arbitrarily rank as true *clingers* all those climbers that possess some special structure or modification which enables them to cling tightly to a support, in contrast to the lax, rambling method of the clamberers. Such special structures or modifications may be seen (1) in the twisting petioles of clematis, several species of which are growing on the trellis bordering the walk, north of the Ranunculaceae or Crowfoot Family of the outdoor plantations; or (2) in the tendrils of the woodbine (*Parthenocissus quinquefolia*), which are short branches expanded at their tips into adherent disks, as may be seen in the Ecological Garden, just east of the Rock Garden; or (3) in the tendrils (modified branches) of the grape, e.g. in the edible-stemmed grape (*Vitis quadrangularis*) at the north end of House 12. This strange looking plant from tropical Asia and Africa is leafless a good part of the year, and so its succulent, 4-angled stems, which are said to be used for food by the natives of Ceylon, evidently assist in the work of photosynthesis. Another closely related plant, with tendrils, and small fruit of a turquoise shade, is *Ampelopsis heterophylla*, the Turquoise Vine, which may be seen close to the walk east of the southern boulder bridge. *Cissus sicyoides*, a native of tropical America, and another tendril climber of the grape family, will be found in House 4 near the door to the Economic House, and is easily recognized by its long, slender, aerial roots, reaching to the ground. Finally, we may place in this group those plants (4) with aerial rootlets of a definite growth, often with disk-like expansions at their tips as in the English Ivy (*Hedera Helix*). to be found near the walk opposite the north end of the Children's Garden.[9]

3. *Twiners*. Perhaps the commonest method of climbing is that in which the stem winds around a given support in a spiral fashion. Although this interesting behavior has been the subject of almost endless research and discussion[10] it is still not completely understood.

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[8] Forms and functions of leaves. Series XIV, No. 9-10, 1927.

[9] The Pepper, *Piper nigrum*, has somewhat longer rootlets, but uses them effectively as climbing organs, as may be seen in the Economic House opposite the entrance to House 10, and also at the east end surrounding and climbing up the rubber plant.

[10] The discussion dates back more than 100 years. Charles Darwin reexamined the whole subject and in 1865 published in the Journal of the Linnaean Society his classic treatise on "The Movements and Habits of Climbing Plants," which later appeared in book form. See Gager, *General Botany*, p. 256. Philadelphia, 1926.

It is known that in many plants the tips of the stems, including the first two or three internodes, revolve very slowly as they grow, describing in space complicated curves which are of the general nature of wide spirals. This is called *circumnutation* and is due directly to changes in the rate of growth, or perhaps also in the turgidity of the tissues, in the young parts of the stem, those tissues on the outer or convex side of the nutating (or "nodding") stem growing more rapidly or becoming more turgid than those of the concave side. On account of the gradual transfer of these conditions to successively adjoining parts of the stem, a bending of the tip in a wide spiral is produced.

Climbing plants circumnutate in greater degree than ordinary plants. At first, in the young seedling stage, growing erect, their upper internodes at length commence to revolve in the air until they come in contact with a support which is more or less vertical and not too thick. This becomes surrounded by the stem as it continues its nutations, resulting thus in a spiral growth around the support. The natural tendency of the older parts of the stem to straighten out, due to negative geotropism, makes the spiral coils steeper and pulls the twiner closer to its support. In case the twiner meets no such support it grows prostrate on the ground until a support is encountered. In its *direction*, if the lower part of the spiral appears from behind the support at the observer's right, rises and disappears from view above at the left, the twiner is called *dextrorse* (*dexter*, right), and the general direction is clockwise; if the coil appears from behind the support at the left, and disappears above at the right, the twiner is called *sinistrorse* (*sinister*, left), and the general direction is counter-clockwise. Usually the direction of twining is constant in any given species, although cases are known e.g. in the bittersweet, or bitter nightshade, *Solanum Dulcamara*, where different individuals or different shoots on the same individual twine in opposite directions. The hop and honeysuckle are dextrorse climbers; moonseed and morning glory are sinistrorse. Following is a list, though not complete, of the twining plants at the Brooklyn Botanic Garden. Their characteristic method of twining, whether dextrorse or sinistrorse, has been purposely omitted, so that the student may have the pleasure of finding this out for himself.

CONSERVATORIES

House 3

- *Aristolochia elegans.* Calico Flower.
- *Aristolochia brasiliensis.*
- *Aristolochia galeata.*
- *Clerodendron Thomsonae.* Thomson Glorybower.

House 4

- *Ipomoea Horsfalliae.*
- *Thunbergia laurifolia.* Laurel. Clockvine.
- *Fischeria sp.*
- *Beaumontia grandiflora.*
- *Stigmaphyllon ciliatum.* Fringed Amazonvine.

House 5

Thunbergia grandiflora. Bengal Clockvine.

House 6

Bowiea volubilis.

PLANTATIONS

Celastrus spp.—Bittersweet. At intersection of paths east of southern boulder bridge.

Lonicera japonica—Japanese Honeysuckle. Fence west of experimental plot, also in Ecological Garden, just east of Rock Garden.

Humulus lupulus—Common Hop. Ecological Garden.

Akebia quinata—Fiveleaf Akebia. On trellis south of Crowfoot Family and s.e. of boulder bridge.

Menispermum canadense—Common Moonseed	On trellis south of Crowfoot Family and s.e. of boulder bridge.
Menispermum dahuricum—Asiatic Moonseed	
Sinomenium acutum—Chinese Moonseed	

b. Creeping Stems. Some plants grow horizontally close to the ground, rooting at the joints of the stem as they advance. As the older parts die out the new growths become separate individuals, a form of vegetative reproduction which is especially prolific where branching occurs abundantly. The white clover, *Trifolium repens,* common in lawns and abundant on the grounds of the Botanic Garden, is one of this class. In the conservatories, in the central or Economic House, two species of *Fittonia,* natives of South America, grow luxuriantly here and there on the ground. The larger-leaved sort, red-veined, is *F. Verschaffeltii;* the other, with the white veins, *F. argyroneura.* They belong to the Acanthus Family, whose genera are tropical. Helxine (*H. Soleirolii*), a small creeping herb of the Nettle Family, from Corsica and Sardinia, may be found in House 11 on the east bench, and also creeping on the floor of House 6. *Hydrocotyle Novae-Zealandae,* a creeper from New Zealand, may be seen in House 11. Two other creepers, *Eranthemum venosum* and *Pellionia pulchra,* pretty little greenhouse plants, may be seen in House 3. Finally, species of Wandering Jew, *Tradescantia* and *Zebrina,* whose wanderlust tendencies are suggested by the common name, are displayed in House 8.

c. Traveling Stems. In this group are classed all those special stem forms which reach out laterally and take root.

1. *Stolons Proper.* Although the term "stolon" is applied rather loosely to *any* rooting branch no matter what its nature and position, in its strictest sense it may be looked upon as a leafy branch which bends over to the ground and roots at the tip, as in the black raspberry, *Rubus occidentalis,* and the red osier dogwood, *Cornus stolonifera.* A yellow-twigged variety of the latter, var. *flaviramea* (yellow branch) is conspicuous at the south end of the dogwood group opposite the entrance to the Children's Garden. *Acanthopanax pentaphyllum,* of which there is a flourishing colony north of the dogwoods,

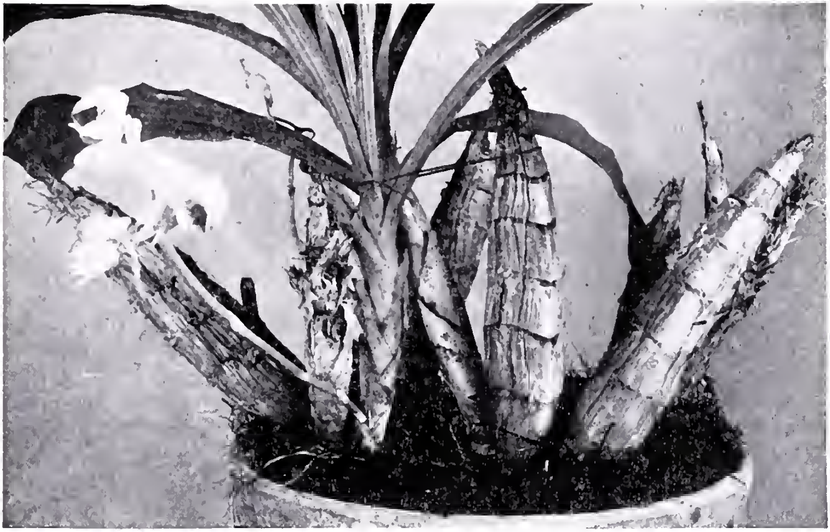

FIGURE 2. Large pseudobulbs of an orchid (*Catasetum sp.*) growing in House 2 of the conservatories of the Brooklyn Botanic Garden.

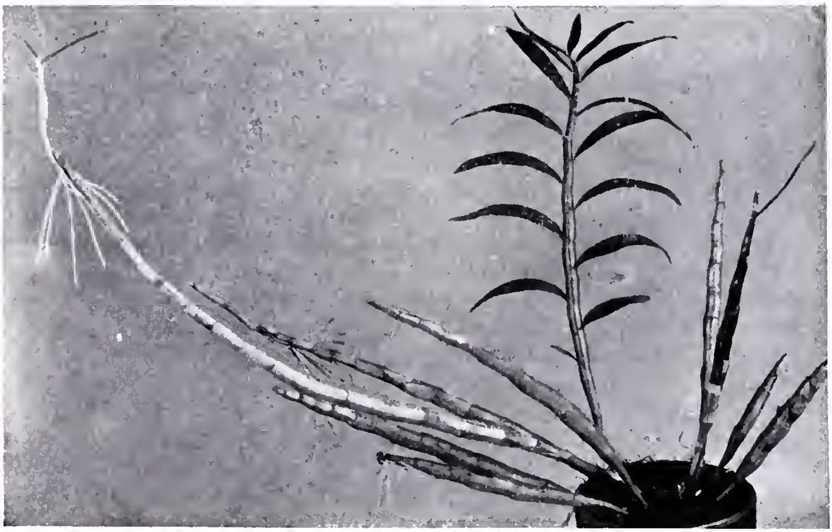

FIGURE 3. Slender pseudobulbs of the orchid *Dendrobium fimbriatum* var. *oculatum* growing in House 2 of the conservatories of the Brooklyn Botanic Garden.

is stoloniferous. Further to the westward, *Forsythia viridissima* and the variety *suspensa* are also stoloniferous, as is the matrimony vine, *Lycium halimifolium*, still further west, near the walk.

The case of the stems of the purple willow, *Salix purpurea*, which has formed a large colony just west of the brook opposite the Rock Garden, is not so clear. Wherever these stems have touched the ground they have rooted, not primarily because of any stoloniferous tendency, but because of the propensity of willow stems to strike root on the slightest provocation. However, the final result is the same: we have here a large colony of purple willow about 30 feet in diameter, all originating from one plant. *Aesculus parviflora*, the shrub horsechestnut, one of the members of the Horsechestnut Family, a little to the eastward of the purple willows, shows a similar condition.

2. *Offsets* are short stolons, really specialized branches next the ground or below its surface, developing a new plant at the tip and rooting there, as in the *Sempervivum* or houseleek which may be found in the Rock Garden and also in House 6; they occur too in species of *Aloe* and *Haworthia* (House 6).

3. *Suckers* are erect shoots, arising from more or less horizontal, subterranean parts. They may appear several feet from the parent plant as in the sumac, *Rhus*, and in such numbers as to establish a colony of the particular species.

4. *Runners* are slender stolons lying on the ground, leafless or almost so, striking root and developing a new plant at the tip, or, as in ferns, at various points along the runner. Runners are more slender than offsets, always above ground; and they establish the new plants at a greater distance from the parent. Species of strawberry (*Fragaria*) and cinquefoil (*Potentilla*) furnish good examples. The ferns in House 10 also show a plentiful supply of runners. *Saxifraga sarmentosa*, the mother-of-thousands, in House 11, develops its "thousands" of plants by means of runners.

d. Pseudobulbs. In contrast to the specialized branches of stems, whose function is reproduction of the plant in a vegetative way, there are other stems which, while they bear foliage leaves, are nevertheless not of the typical form and have added functions. Such are the pseudobulbs common among the orchids, as seen in House 2. In some species they are long and spindle-shaped, representing several nodes and internodes, in others shorter, consisting of about one internode more or less enlarged. They function in the storage of both water and food. *Coelogyne*, *Oncidium*, *Cattleya*, *Schomburgia*, *Dendrobium*, and *Catasetum* furnish good examples. In the last the pseudobulbs are a little longer and thicker than a banana, include 10 or more nodes, and are more or less erect. (Figures 2 and 3.)

III. STEM STRUCTURES NOT DIRECTLY CONNECTED WITH FOLIAGE BEARING.

Under this heading we may group all those stem forms that show still greater modification from the type in that they do not bear green leaves, or at least ordinary foliage leaves.

a. Rootstocks or rhizomes are horizontal, subterranean stems, recognizable as stem structures by their nodes, scale leaves, and buds. (Figure 4.) Slender rootstocks are found in the grasses, any piece of turf being composed of a network of these, branching in all directions in a horizontal plane and sending up short, erect shoots bearing the blades of grass. More thickened rootstocks, in which large quantities of food are stored, may be seen in the iris in the plantation along the brook, and in the sweet flag, *Acorus Calamus,* in the brook near the northern boulder bridge. At the south side of the Economic House of the conservatories is the taro, *Colocasia antiquorum,* while in the center of this house is a closely related plant, the yautia, also known as malanga, *Xanthosoma sagittifolium.* These have stout rootstocks, with both vertical and horizontal branches, the latter often of a tuberous nature.[11]

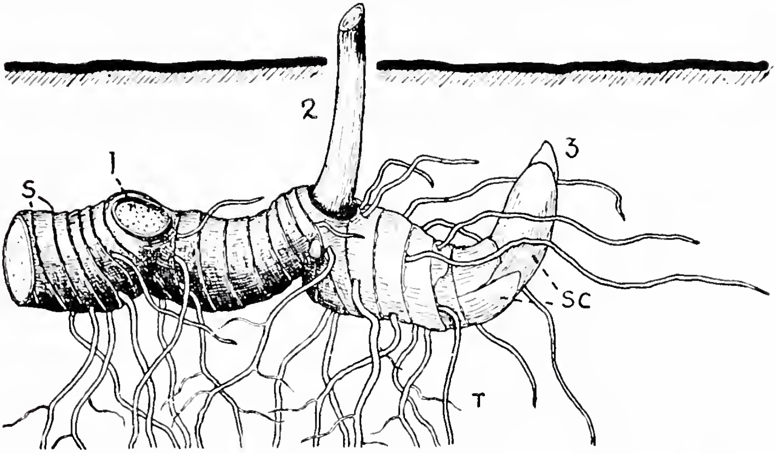

Figure 4. Diagram of rootstock of Solomon's Seal. 1, scar of last year's aerial shoot; 2, base of this year's shoot; 3, bud which will produce next year's shoot; *sc,* scale leaves; *s,* scars of old scale leaves; *r,* roots. (From *Botany, a junior book for schools,* by R. H. Yapp. Cambridge University Press. 1923.)

b. Corms. A corm is a thickened, rounded stem structure resembling a bulb in appearance, but without the scales or with inconspicuous ones. It is provided with a bud at the tip and often has more than one of these. Examples of the corm may be seen in the crocus and jack-in-the-pulpit. Thousands of crocuses are naturalized in the lawns in the southwestern part of the Garden.

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[11] For interesting and valuable accounts of these plants, whose root-stocks and tubers form a large part of the diet in tropical countries, see Bull. 164, Bur. of Plant Industry, U. S. Dept. Agric. Promising root crops for the south. I. Yautias, taros, and dasheens, by O. W. Barrett; and II. Agricultural history and utility of the cultivated aroids, by O. F. Cook. 1910.

c. **Bulbs** are similar in form, but instead of being solid are composed of overlapping layers of scale leaves surrounding the growing point in the center. The scales contain a store of food to start the future green plant on its way. Examples are the onions (*Allium*), of which several species may be seen among the Lily Family representatives in the outdoor plantations; tulip, and hyacinth, also in the Lily Family compartment. *Bowiea volubilis* in House 6 of the conservatories, a curious South African plant of the Lily Family, forms large bulbs which send up annually a slender, twining shoot.

d. **Tubers.** When underground stems become much thickened at their tip they form definite reproductive bodies called tubers, e.g. the white potato (*Solanum tuberosum*). See pp. 2 and 3.

e. **Tendrils** are slender, threadlike structures which coil about a support, enabling plants to climb. Some times these are modified leaflets, and sometimes stipules,[12] but often they are modified stem structures, as evidenced by their origin in the axil of a leaf or from the fact that they appear where a leafy branch would otherwise occur, as in *Cissus sicyoides*, House 4, near the door to the Economic House, in the granadilla, *Passiflora quadrangularis*, in the Economic House near the door of House 10, and in the several species of grape near the walk leading to the southern boulder bridge.

f. **Spines, or Thorns,** which are morphologically stem structures, may be seen in the hawthorns in the plot east of the tropical-lily pool, in the osage orange, *Maclura aurantiaca*, among the Mulberry Family in the outdoor plantations just east of the monocotyledons, and in the honey locust, *Gleditsia triacanthos*, on the border mound north of the Walnut Family. The buckthorns illustrate well transition stages between thorn-shoots, i.e. leafy shoots ending in thorns, and leafless thorns. Several species are growing, with other members of the Buckthorn Family, east of the experimental plot, and across the walk from the horsechestnuts. Of these the Chinese buckthorn, *Rhamnus utilis*, shows the thorn-shoots best.

g. **Peduncles, Pedicels,** and **Receptacles.** Peduncles and pedicels are the stalks which support flowers, and except for this difference in function, and the fact that they bear only modified foliage leaves, if any, show no essential difference from ordinary foliage-bearing stems. When entirely naked, and rising from the ground, as in the flower stalks of the violet, they are called *scapes;* if they bear small or otherwise modified leaves, the latter are known as *bracts*. The *receptacle* is a slightly enlarged portion of the stem composed of several nodes and internodes merged together and bearing the floral organs.

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[12] See Series XIV, No. 9-10, p. 5.

h. Phylloclades. When a short branch of definite (i.e. limited) growth has become flattened and assumes the appearance and functions of a leaf, it is called a *phylloclade* (leaf-branch). Such a case is seen in the butcher's broom (*Ruscus aculeatus*) in House 11, and in the plant sold by the florists under the name of smilax (*Myrsiphyllum asparagoides*), as also in asparagus, species of which may be found at the further end of House 8, and in the Lily Family compartment in the outdoor plantations.

i. Cladodes are flattened stems of more indefinite growth than the previous class. Their leaves are either transient or scalelike, or entirely absent. The green, flattened stems of the lobeberry, *Muehlenbeckia platyclados*, in House 3, or the cacti in House 6, particularly species of *Opuntia, Phyllocactus*, and *Epiphyllum* are good examples. In the melon cacti (*Echinocacti*) the globular, leafless stem does not fall into this group, but really belongs to a class by itself. The same is true of the knotweed *Polygonum equisetifolium* (House 11), and of *Bowiea volubilis*, House 6, whose long, weak, slender stems perform all the work of photosynthesis. In the former the leaves are reduced to mere sheaths; in the latter they are small scales.

SYNOPSIS OF PARTS II AND III

II. FOLIAGE-BEARING STEMS WITH SPECIAL MODIFICATIONS

a. Climbing Stems.

1. *Clamberers.*

Poison ivy, *Rhus toxicodendron*, near border mound in southwest part of Garden. Ceriman, *Monstera deliciosa*, House 5. Purple wreath, *Petraea volubilis*, and *Allamanda cathartica* var. *Williamsii*, House 3. *Norantea guianensis*, House 4. *Rubus australis*, House 11. *Rosa wichuriana*, Japanese Garden. Rangoon creeper, *Quisqualis indica*, and vanilla, *V. planifolia*, House 5.

2. *Clingers.*

Clematis, outdoor plantations. Woodbine *Parthenocissus quinquefolia*, Ecological Garden, outdoor plantations. Edible-stemmed grape, *Vitis quadrangularis*, House 12. *Cissus sicyoides*, House 4. Pepper, *Piper nigrum*, House 5. Turquoise vine, *Ampelopsis heterophylla*, and species of grape, *Vitis*, and English ivy, *Hedera Helix*, outdoor plantations.

3. *Twiners.*

See list and locations, pp. 9 and 10.

b. Creeping Stems.

White clover, *Trifolium repens*, lawns of outdoor plantations. *Fittonia Verschaffeltii* and *argyroneura*, Economic House. Helxine (*H. Soleirolii*), House 6. *Hydrocotyle Novae-Zealandae*, House 11. Eranthemum venosum and *Pellionia pulchra*, House 3. Wandering Jew, *Tradescantia and Zebrina*, House 8.

c. Traveling Stems.

1. *Stolons Proper.*

   Cornus stolonifera var. *flaviramea*, nearly opposite entrance to Children's Garden. *Acanthopanax pentaphyllum*, nearby to northward. *Forsythia viridissima* and var. *suspensa* and *Lycium halimifolium*, to westward; in this connection also purple willow, *Salix purpurea*, along brook to north, and the shrub horsechestnut, *Aesculus parviflora*, east of last.

2. *Offsets.*

   Sempervivum in Rock Garden and House 6. *Aloe* and *Haworthia*, House 6.

3. *Suckers.*

   Species of sumac, e.g. staghorn sumac, *Rhus typhina*, in northwestern part of outdoor plantations.

4. *Runners.*

   Strawberry, *Fragaria*, and cinquefoil, *Potentilla*, in outdoor plantations. Ferns in House 10. *Saxifraga sarmentosa*, House 11.

d. Pseudobulbs.

Orchids in House 2.

III. STEM STRUCTURES NOT DIRECTLY CONNECTED WITH FOLIAGE BEARING.

a. Rootstocks or Rhizomes.

Grasses, iris along brook, and sweet flag, *Acorus Calamus*, in brook near northern boulder bridge. Taro, *Colocasia antiquorum*, and yautia, *Xanthosoma sagittatum*, in Economic House.

b. Corms.

Crocuses in outdoor plantations.

c. Bulbs.

Onions, lilies, tulips, and hyacinths in Lily Family compartment in outdoor plantations. *Bowiea volubilis*, House 6.

d. Tubers.

White potato, *Solanum tuberosum*, Potato Family, outdoor plantations.

e. Tendrils.

Cissus sicyoides, House 4. Turquoise vine and species of grape near walk leading to southern boulder bridge.

f. Spines and Thorns.

Hawthorns in Apple Family plot; osage orange, *Maclura aurantiaca*, Mulberry Family; honey locust, border mound to northwestward; and buckthorns, south of the hollies and horsechestnuts.

g. Peduncles, Pedicels, and Receptacles.

Associated with flower production.

h. Phylloclades.

Butcher's broom, *Ruscus aculeatus*, House 11. Florist's smilax, *Myrsiphyllum asparagoides*, and asparagus, House 8.

i. Cladophylls.

Lobe-berry, *Muehlenbeckia platyclados*, House 3. *Opuntia*, *Phyllocactus*, *Epiphyllum*, etc., House 6. Cf. melon cacti (*Echinocacti*), House 6, *Polygonum equisetifolium*, House 11, and *Boweia volubilis*, House 6.

Arthur Harmount Graves.